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ABSTRACT

This report correlates the college transfer mathematics courses in the Virginia community colleges with their counterparts at 13 state four-year colleges and universities. Data were collected by examining four-year college catalogues, correlating this information with course descriptions in the Virginia Community College Curriculum Guidelines (VCCCG), and surveying mathematics department chairpersons to validate the correlations. Of the 66 different mathematics sequences described in the VCCCG, 16 have potential counterparts at the senior colleges. The remainder are either remedial or especially designed for technical or vocational programs. Of the 16 equivalent courses, six are taught by almost all the Virginia community colleges. Although it appears that the mathematics courses listed in the VCCCG are well designed to meet the needs of Virginia's two-year college transfer students, one possible exception is the absence of a course specifically designed to provide a mathematics background for the elementary school teacher. Summaries of the general comments offered by the four-year college mathematics chairpersons concerning curriculum articulation are included, information is organized into five tables, and lists of textbooks used at the community and four-year colleges are appended. (NHM)

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VIRGINIA COMMUNITY COLLEGE

MATHEMATICS CURRICULUM STUDY

(1975-76)

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PREFACE

This report is published by the Virginia Department of Community Colleges as a service to mathematics and admissions personnel at institutions of higher education in Virginia. The report is essentially the first revision of a similar study conducted by the authors during the 1973-74 academic year. That study, entitled Virginia Community College Curriculum Study contained a somewhat more comprehensive analysis of the Virginia community colleges' mathematics curriculum than does the revised edition, so it may yet be of some interest to community college educators.

The revision was completed in March, 1975, so all information contained herein must be interpreted within the limits of that time frame. While the accuracy of this particular report will diminish as a function of time, we intend to update the data contained in the study on a periodic basis and distribute copies to interested faculty and administrators at State colleges and universities. We hope that these reports will inspire increased articulation between Virginia's community and four-year colleges.

CAH
RWH

INTRODUCTION

In a recent publication of the State Council for Higher Education in Virginia, Winandy and Schultz asserted that "it now appears that the success of higher education services in Virginia depends as much on a student's ability to move from one college to another, as upon his opportunity to gain admission as a college freshman." While this may be a slight exaggeration, it, nevertheless, indicates the need for continuous curricula articulation between the community colleges and senior institutions in Virginia.

The principal purpose of this report is to correlate the college transfer mathematics courses in the Virginia Community College Curriculum Guidelines (VCCCG) with their counterparts at thirteen state four-year colleges and universities. We must emphasize that we have not attempted to explain how all community college mathematics courses will transfer to the senior colleges. It is quite likely that Math X, a fictitious course in the VCCCG, will satisfy part of the mathematics requirement in program Y at four-year College Z, even though College Z does not have a course similar to Math X in its own mathematics curriculum. Our point is that college transfer is essentially the act of an individual student performed many times over and any attempt to explain all conceivable situations would produce guidelines that would be extremely unwieldy. Consequently, we have merely attempted to show which courses in the four-year college curricula are, for all practical purposes, the same as certain courses in the Curriculum Guidelines. In this respect, the authors believe that this report can provide some useful guidance to both mathematics and admissions personnel in Virginia's institutions of higher learning.

The mathematics chairperson at each of the four-year institutions was invited to include pertinent comments on the questionnaires used to collect the data included in this report, and, since it seemed likely that those comments would be of considerable interest to community college mathematics faculty, we have included them in the penultimate section of the report. Finally, we make some comments and suggestions which may bear consideration by the mathematics faculties at both the community colleges and the four-year institutions in Virginia. Data for the study were obtained from mathematics department chairpersons in December 1974 and January 1975.

BACKGROUND

There are seventy-one separate course sequences in mathematics in the Virginia Community College Curriculum Guidelines. These sequences are either of one, two, or three quarters duration. For example, Math 121-122-123, which is Engineering Technical Mathematics 1-11-111, is a three-quarter sequence of courses with a total of fifteen quarter-hours credit (five hours per quarter).[1] Math 274, Applied Mathematics, is a one-quarter course carrying four hours of credit. Several of the sequences are actually identical in course content, but differ in the teaching schedule. By way of illustration, the only difference between Math 101-102-103, Fundamentals of Mathematics, and Math 104-105, Funda-

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[1]All course credit in this study will be reported in quarter-hours. The conversion factor for changing semester-hours credit to quarter-hours credit is 3/2. For example, 3 semester-hours = (3/2) (3) = 4 1/2 quarter-hours.

mentals of Mathematics, is that the former is a three-quarter sequence, while the latter is taught in two quarters and enables the community colleges to offer their students rather flexible programs of study. Both courses carry a total of nine quarter-hours credit. If these duplications are eliminated, then there are sixty-six different sequences in mathematics described in the VCCCG.

COMMUNITY COLLEGES' BASIC COLLEGE TRANSFER COURSES

Of the sixty-six different sequences in the Curriculum Guidelines, sixteen have potential counterparts at the senior colleges. The remainder are either developmental (remedial) or especially designed for technical or vocational programs.[2] Of these sixteen sequences only six are taught (or at least advertised) by almost all of the Virginia community colleges (see Table 1).

The information in Table 1 was assembled in the following manner. The authors examined the official community college catalogs and determined on that basis the course offerings of the respective schools. Then questionnaires were sent to the community college mathematics department chairpersons with a request that they up-date these data by deleting all courses listed in their colleges' catalogs that had not been taught during the past two years. They were also asked to add those courses which were not listed but had, in fact, been taught during that time period.

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[2]Many of these courses will transfer in certain programs, but they are not courses which are taught at the four-year colleges.

Table 1

College Transfer Mathematics Courses Offered by Virginia Community Colleges

	Wytheville	Virginia Western	Virginia Highlands	Tidewater	Thomas Nelson	Southwest Virginia	Southside Virginia	Rappahannock	Piedmont Virginia	Paul D. Camp	Patrick Henry	Northern Virginia	New River	Mountain Empire	Lord Fairfax	John Tyler	J. Sargeant Reynolds	Germanna	Eastern Shore	Danville	Dabney S. Lancaster	Central Virginia	Blue Ridge
Fund. of Math 101-102-103				X						X		X					X			X		X	
Fund. of Math 104-105				X						X													
College Alg. and Trig. 131-132-133																							
Intro. Math Analysis 141-142-143	X	X	X	X	X	X			X	X	X	X	X		X	X	X	X	X	X		X	X
College Math 161-162-163	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
College Math 164-165				X	X		X		X	X	X							X					
Intro. to Calculus 177										X										X			X
Gen. College Math 181-182-183	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Gen. College Math 184-185					X		X																
Finite Math 191-192-193									X		X	X				X						X	
Modern Math 200																							
Intro. to Matrix Algebra 202											X												
Survey of Math Concepts 206																							
Advanced Tech. Math 211					X								X										
Advanced Math Analysis 241-242-243	X	X	X	X	X	X			X	X		X	X			X	X		X	X		X	X
Advanced College Math 261-262-263												X								X			
Calculus 271-272-273		X			X		X	X	X		X		X	X		X	X					X	
Applied Math 274																							
Intro. to Statistics 280		X			X				X						X								
Tech. Math 111-112-113		X	X	X	X	X	X	X	X				X	X	X		X				X	X	X
Eng. Tech. Math 121-122-123	X	X		X	X	X						X					X					X	
Intro. Bus. Math 151-152-153	X	X	X	X	X		X	X			X	X	X		X	X	X	X	X	X		X	X
Intro. Math Logic 156																	X						
Math of Finance 171-172-173				X																			

It is easy to see that there are nine mathematics sequences (not including developmental studies courses) which are taught at almost all of the community colleges. Table 1 clearly reveals the fact that the core of the college transfer mathematics curriculum in practically every college is composed of

Introductory Mathematical Analysis 141-142-143
College Mathematics 161-162-163
General College Mathematics 181-182-183
Advanced Mathematical Analysis 241-242-243
Advanced College Mathematics 261-262-263 or Calculus 271-272-273.

In addition to these six courses, most community colleges offer Technical Mathematics 111-112-113, Engineering Technical Mathematics 121-122-123, and Business Mathematics 151-152-153. These three sequences of courses are usually taken by students pursuing the Associate in Applied Science Degree. While the AAS is a terminal two-year degree, in recent years many of the courses satisfying the credit requirement for it have been accepted for credit in certain transfer programs at four-year institutions - for example, in VPI & SU's Bachelor of Technology program.

It is reasonable to assume, then, that a cross-referenced list matching only six courses in the Community College Curriculum Guidelines with their counterparts at Virginia's four-year institutions would provide sufficient information for a large portion of transfer students. Table 2 represents a fairly accurate attempt at coordinating these courses. The data for this table were collected in the following manner. The authors ordered the catalogs from the senior institutions, read the course descriptions, and attempted to match the courses with those in the VCCCG. Then the descriptions of the community college courses were sent along with our conjectured associations of courses to each four-year college mathematics department chairperson.

The respondents were asked to either validate or correct our conjectured course associations.

The titles and descriptions of the courses in question as they are listed in the State Guidelines are:

> MATH 141-142-143, INTRODCTORY MATHEMATICAL ANALYSIS 1-11-111, (5 cr.), (5 cr.), (5 cr.). Prerequisites are a satisfactcry score on appropriate mathematics proficiency examinations and four units of high school mathematics including two units of algebra, one of geometry, and one-half of trigonometry or equivalent. A modern unified course in analytic geometry and calculus including functions, limits, derivatives, differentials, indefinite integrals, definite integrals, and applications. Lecture 5 hours per week.
>
> MATH 161-162-163, COLLEGE MATHEMATICS 1-11-111, (3 cr.), (3 cr.), (3 cr.). Prerequisites are a satisfactory score on appropriate mathematics proficiency examinations and three units of high school mathematics including two units of algebra and one unit of geometry or equivalent. A modern unified course in algebra, trigonometry, analytic geometry, and calculus for students other than those in engineering. Lecture 3 hours per week.
>
> MATH 181-182-183, GENERAL COLLEGE MATHEMATICS 1-11-111, (3 cr.), (3 cr.), (3 cr.). Intended for students with majors other than mathematics, science or engineering. Prerequisites are Algebra I and either Algebra II or Geometry and a satisfactory score on appropriate mathematics proficiency examinations. The first two quarters will include sets, the logic of algebra, the real number system, algebraic and transcendental functions, relations and graphs. The third quarter will include permutations, combinations, probability and elementary statistics. Lecture 3 hours per week.
>
> MATH 241-242-243, ADVANCED MATHEMATICAL ANALYSIS 1-11-111, (4 cr.), (4 cr.), (4 cr.). (For students in Engineering and Science Curricula.) Prerequisite is Math 143. A modern course including vectors, matrices, partial differentiation, multiple integrals, infinite series, and differential equations. Lecture 4 hours per week.
>
> MATH 261-262-263, ADVANCED COLLEGE MATHEMATICS 1-11-111, (3 cr.), (3 cr.), (3 cr.). Prerequisite is Math 163 or equivalent. A continuation of the unified course in algebra, trigonometry, analytic geometry, and calculus for students other than those in engineering. Topics included are differentiation and integration of exponential, logarithimic, and trigonometric functions; sequences and series: solid analytic geometry; multiple integrals; an introduction to differential equations, Lecture 3 hours per week.

MATH 271-272-273, CALCULUS 1-11-111, (4 cr.), (4 cr.), (4 cr.). Prerequisite is Math 163 or equivalent. Topics include functions, limits, continuity, differentiation and integration of algebraic, trigonometric, and hyperbolic functions with applications, vectors in three dimensions, definite integrals, indeterminate forms, and partial differentiation. Lecture 4 hours per week.

In Table 2 the credit for each course at the senior institution is written in parentheses below the course number. It is generally the case that when the credit for a community college sequence exceeds that of a four-year institution's corresponding sequence, the transfer student with acceptable grades will get full credit for the course and the balance of his quarter-hours will be counted as elective credit. If the credit for a community college sequence is less than that of an associated four-year school's course, then the student will probably be given credit for the course, but he will only be credited with the number of quarter-hours completed at the two-year college. In short, we emphasize that although Table 2 provides a guide for credit evaluation, the awarding of credit-hours to a transfer student will be done on an individual student basis.

Close scrutiny of Table 2 will reveal a number of interesting facts about specific community college "core" courses, so we will make several observations in a sequence-by-sequence analysis.

Math 141-142-143

It is reasonable to believe that the community college student with a good record of performance in Math 141-142-143 will have no difficulty in transferring that course to a state four-year institution. Practically every mathematics, math-related science, or engineering major in Virginia is required to complete, at the minimum, this sequence; so the community colleges would appear to be serving these students well.

Table 2

Comparison of Virginia Community College Basic Transfer Mathematics Sequences with Similar Courses at Thirteen Virginia Colleges

	COMMUNITY COLLEGE COURSES						
	Math 141-142-143 (15 Cr.)	Math 161-162 (6 Cr.)	Math 163 (3 Cr.)	Math 181-182-183 (9 Cr.)	Math 241-242 (8 Cr.)	Math 243 (4 Cr.)	Math 261-262-263 Math 271-272-273 (9 Cr.) (12 Cr.)
George Mason University (S)	Math 113-114 (12 Cr.)	Math 101 (No Cr.)			Math 213 (4 1/2 Cr.)	Math 214 (4 1/2 Cr.)	
Longwood College (S)	Math 261-262 (15 Cr.)	Math 161-162 (9 Cr.)	Math 164 (4 1/2 Cr.)	Math 111-112 (9 Cr.)	Math 361 (4 1/2 Cr.)	Math 460 (4 1/2 Cr.)	Math 262-361 (12 Cr.)
Madison College (S)	Math 235-236 (15 Cr.)	Math 125-135 (9 Cr.)	Math 205 (4 1/2 Cr.)	Math 107-108 (9 Cr.)	Math 237 (4 1/2 Cr.)	Math 386 (4 1/2 Cr.)	Math 205-206 (9 Cr.)
Mary Washington College (S)	Math 121-221 (9 Cr.)	Math 111 (4 1/2 Cr.)		Math 101 (4 1/2 Cr.)	Math 231 (4 1/2 Cr.)	Math 312 (4 1/2 Cr.)	Math 121-221-231 (13 1/2 Cr.)
Norfolk State College (S)	Math 54-55 (8 Cr.)	Math 51 (3 Cr.)	Math 58 (3 Cr.)	Math 20-21 (6 Cr.)	Math 55-56 (6 Cr.)	Math 157 (3 Cr.)	Math 54-55-56 (12 Cr.)
Old Dominion University (S)	Math 115-211 (12 Cr.)	Math 112-113 (9 Cr.)	Math 115 (6 Cr.)	Math 107-108 (9 Cr.)	Math 212-213 (12 Cr.)	Math 308 (6 Cr.)	Math 205 (4 1/2 Cr.)
Radford College (Q)	Math 141-2-3-4 (16 Cr.)	Math 137 (4 Cr.)	Math 141 (4 Cr.)	Math 101-103-104 (9 Cr.)	Math 144-145 (7 Cr.)	Math 346 (3 Cr.)	Math 141-142-143 (12 Cr.)
University of Virginia (Applied)(S)	APMA 101-102 (12 Cr.)				APMA 205 (6 Cr.)	APMA 206 (6 Cr.)	
University of Virginia (S)	Math 121-122 (9 Cr.)				Math 221 (4 1/2 Cr.)		
Virginia Commonwealth University (S)	Math 200-201 (12 Cr.)	Math 101-102 (9 Cr.)		Math 115-116 (9 Cr.)	Math 202 (6 Cr.)	Math 301 (4 1/2 Cr.)	Math 200-201 (12 Cr.)
V. M. I. (S)	Math 115-116 (9 Cr.)				Math 201-202 (10 1/2 Cr.)	Math 211 (4 1/2 Cr.)	
V. P. I. and S. U. (Q)	Math 1211-12-13 (15 Cr.)	Math 1011-1012 (6 Cr.)	Math 1013 (3 Cr.)	Math 1020 + 6 hrs elective (9 Cr.)	Math 2211-2212 (6 Cr.)	Math 2213 (3 Cr.)	Math 2011-12-13 (9 Cr.)
Virginia State College (S)	Math 16-17-216 (13 1/2 Cr.)	Math 14-15 (12 Cr.)	Math 18 (4 1/2 Cr.)	G.E. 12-13 (9 Cr.)	Math 316-317 (9 Cr.)	Math 217 (4 1/2 Cr.)	
William and Mary (S)	Math 111-112 (8 Cr.)	Math 103 (4 1/2 Cr.)		Math 105-106 (9 Cr.)	Math 212 (4 1/2 Cr.)	Math 212 (4 1/2 Cr.)	Math 111-112-212 (13 1/2 Cr.)

S indicates a school on the semester system.
Q indicates a school on the quarter system.

Math 241-242-243

Many students who take the 141-142-143 courses continue on into Math 241-242-243. In Table 2, the first two quarters of this sequence are separated from Math 243 since the latter is, in fact, a course in differential equations. In some four-year colleges there seems to be a move toward incorporating topics of linear algebra into this sequence. For example, see the comments regarding VPI & SU's course on page 19. In any case, no problem should be encountered by a student with acceptable grades attempting to transfer Math 241-242-243 to a state institution.

Math 161-162

In virtually every community college the "partial sequence" Math 161-162 is generally referred to as pre-calculus mathematics. Some of the four-year colleges (George Mason, U. Va., V.M.I.) do not have specific courses designed to prepare the student for the study of calculus, but most do. That these pre-calculus courses are fairly well tailored to the individual goals of the departments is evidenced by the fact that Radford offers only three quarter-hours in its sequence, while Old Dominion's includes fifteen quarter-hours. The community college's versatile combination of developmental studies and Math 161-162 should provide students with the mathematical background required as a prerequisite for the "lower level" calculus sequences. In addition, we learned that some community colleges utilize this sequence as a prerequisite for Math 141 for students with weak high school backgrounds.

Math 163

Analysis of the questionnaire responses from the community colleges indicates that Math 163 satisfies two separate functions in their curricula.

A number of the colleges treat this course as the concluding one in the unified pre-calculus sequence Math 161-162-163. In other words, the chairpersons at these schools believe that our division of the sequence into Math 161-162, and Math 163 does not accurately reflect a real mathematical distinction. They and a number of other community college instructors believe that many of their students need a full year of elementary mathematics in preparation for the calculus sequences, so they use this sequence for that purpose.

On the other hand, a majority of the chairpersons reported that at their colleges, Math 163 is essentially an elementary differential calculus course. It is fairly easy to see which schools utilize Math 163 in this manner by examining the list of textbooks in Table 5.

Math 181-182-183

Math 181-182-183 is perhaps the most broadly interpreted sequence of courses in the mathematics section of the Curriculum Guidelines. It is safe to say that during the 1974-75 academic year it will be taught in the Virginia community colleges from three completely different points of view. Some will interpret it to be a series of courses in finite mathematics. Others (including the authors of this report) consider it to be a course in mathematics for liberal arts students.[3] The majority of community colleges, however, will be teaching topics in mathematics for elementary school teachers in their Math 181-182-183 course. In truth, its

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[3]It has been cross-referenced with Madison's course called "Mathematics: A Cultural Approach."

description in the Guidelines would indicate that it is none of these courses.

A mathematics course for elementary teachers should probably contain at least one quarter of study in geometry and measurement. It should include some elementary number theory, a study of modular arithmetic, groups and other abstracts systems, and contain elementary introductions to set theory and symbolic logic.[4] None of these topics are even suggested in the course description, but analysis of the texts used for the course reveals that these topics may, in fact, be included in the Math 181-182-183 series at some schools (see Appendix 1).

On the other hand, a course examining mathematics as a liberal art should examine the beauty, scope, vitality, historical significance, and cultural contribution of the subject. It should also consider the impact of mathematics on Western civilization. Certainly, the 181-182-183 sequence as described in the Guidelines is not a course of this nature.

Now compare the course description of 181-182-183 (page 6) with the one for Math 191-192-193 below.

> MATH 191-192-193, FINITE MATHEMATICS 1-11-111, (3 cr.), (3 cr.), (3 cr.). This course is intended for students with majors other than mathematics, science or engineering. Prerequisites are a satisfactory score on appropriate mathematics proficiency examinations and three units of high school mathematics including two units of algebra and one unit of geometry or equivalent. Set theory, the real number system, probability theory, vectors, matrices, linear programming, systems of linear equations, introduction to theory of games. Lecture 3 hours per quarter.

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[4] In the course description for 181-182-183, there is some confusion regarding the meaning of "the logic of algebra." Some community college teachers have been interpreting that to mean "the algebra of logic" which is quite another thing. These two interpretations exemplify the widely varying approach to the course.

The course descriptions would indicate that in two of the three quarters, the material covered in these two sequences is practically identical.

In any case, Table 2 was constructed with the idea in mind that Math 181-182-183 is a general education type course specifically designed for liberal arts majors. Any other interpretation of the course would greatly alter the associations made in the table. Our point is that Math 181-182-183, instead of being an easily identified transfer course, will, depending upon the community college at which it is taught, fit a number of different transfer slots.

Math 261-262-263

Math 261-262-263 is an elementary calculus sequence. It is essentially designed to be the natural extension of the 161-162-163 series; so at those colleges which teach differential calculus in Math 163, we find that Math 261 is integral calculus and more advanced topics are treated in 262 and 263. Alternately, when Math 163 is included in the pre-calculus sequence, 261 and 262 are differential and integral calculus, and somewhat more advanced topics are studied in 263.

In any case, this sequence of courses introduces the student to calculus at the intuitive (as opposed to the theoretical) level. It appears to be especially well-suited for students in business curricula as well as those in social science programs requiring some "advanced" quantitative proficiency. We conjecture that as those state institutions which were once predominantly teacher training institutions continue to redefine their goals, both the Math 261-262-263 series and the Math 271-272-273 series will become increasingly more important in the community college curricula. At present, in most com-

munity colleges the trend seems to be to discontinue offering Math 261-262-263, replacing it with Math 271-272-273.

Math 271-272-273

Our initial conjecture regarding Math 271-272-273 and Math 261-262-263 was that, although their course descriptions were slightly different, they were essentially the same course in terms of content and "degree of difficulty" at the instructional level. It is noteworthy that the majority of the community colleges offer one or the other of these two sequences but no college offers both. Our verbal interaction with mathematics instructors and chairpersons at the community colleges seemed to reinforce this supposition, however a glance at Table 5 indicates that there is considerable overlap between the texts used for Math 271-272-273 and Math 141-142-143. Problems of interpretation are compounded in the sense that several community colleges encourage their students to enroll in Math 141-142-143 in lieu of either of the aforementioned courses, neither of which are offered at those institutions.

OTHER COLLEGE TRANSFER COURSES

Of the ten remaining sequences which are potentially college transfer courses, three fit rather neatly into the four-year institutions' curricula. Two of the sequences are described below, and the third course, Finite Mathematics, was outlined on page 11. These courses are cross-referenced with their counterparts from the four-year colleges in Table 3.

> MATH 202, INTRODUCTION TO MATRIX ALGEBRA, (4 cr.). Prerequisite is Math 163 or Math 143 or equivalent. Operations with matrices, determinants, systems of linear equations, vector spaces and linear transformations, bilinear and quadratic forms. Lecture 4 hours per week.

MATH 280, INTRODUCTORY STATISTICS, (5 cr.). Prerequisite is Math 162 or equivalent. Introduction to statistics including a brief treatment of descriptive statistics, problems of sampling, estimation, testing of hypotheses, regression, and correlation. Lecture 5 hours per week.

Math 191-192-193

Math 191-192-193 is taught at only five community colleges even though responses from four-year institutions indicate that ten of them have a comparable course in their curricula. Furthermore, finite mathematics is a course with substantial utility in certain programs at several of the senior colleges (e.g. at VPI & SU), so more community colleges should investigate the possibility of adding at least Math 191 to their curricula. It is interesting to note that at the time of our previous study of transfer courses two years ago, five community colleges taught this sequence, but two have dropped it and a like number have added the sequence in the interim.

Math 202

Northern Virginia C. C. is currently offering Math 202, the community colleges' course in matrix algebra. Although the VCCCG course outline parallels that of most of the four-year institutions' matrix algebra courses, there may be some difficulty with transfer credit since matrix algebra is a 300-level course at several state colleges. This probably means that it is taught at the junior or senior level, so some senior colleges may conclude that the community college course is not comparable to their algebra course. Nevertheless, Table 3 indicates that eight senior colleges will accept Math 202 as a course equivalent to a matrix algebra course in their mathematics curriculum.

Math 280

The Introduction to Statistics course, Math 280, is taught at Piedmont Virginia, Virginia Western, Thomas Nelson, and Lord Fairfax. Reponses to our questionnaire indicate that this course will transfer to ten four-year institutions. In order to facilitate transfer, however, it may be advantageous to include one-way analysis of variance and chi-square tests of independence and goodness of fit in the VCCCG course description.

The transferability of the seven sequences listed in Table 1 which have not been previously examined is, of course, a function of where the student wishes to enroll and what program he intends to pursue. These courses are:

> MATH 101-102-103, FUNDAMENTALS OF MATHEMATICS 1-11-111, (3 cr.), (3 cr.), (3 cr.). A study of concepts of numbers; fundamental operations with numbers, formulas and equations, graphical analysis, binary numbers, Boolean and Matrix algebra, linear programming, elementary concepts of statistics. Lecture 3 hours per week.
>
> MATH 131-132-133, COLLEGE ALGEBRA AND TRIGONOMETRY 1-11-111, (3 cr.), (3 cr.), (3 cr.). Prerequisites are three units of high school mathematics or equivalent and a satisfactory score on appropriate mathematics proficiency examinations. Sets and numbers, the logic of algebra, functions, algebraic and transcendental, determinants, the binomial theorem, mathematical induction, trigonometry, applications. Lecture 3 hours per week.
>
> MATH 170, INTRODUCTION TO CALCULUS, (4 cr.). Prerequisite is Math 34 or equivalent. An introduction to calculus applied to practical graphical and mathematical operations in slopes, averages, derivations, increments, areas under graphs, maxima and minima, limits, differentiation, and integration. Lecture 4 hours per week.
>
> MATH 200, MODERN MATHEMATICS, (3 cr.). Prerequisite is Math 133 or equivalent. Elements of logic, Boolean algebra, matrices, linear programming, operation with sets, probability, and statistics. Lecture 3 hours per week.

Table 3

Comparison of Virginia Community College Transfer Mathematics Sequences with Similar Courses at Thirteen Virginia Colleges

	COMMUNITY COLLEGE COURSES				
	Math 131-132-133 (9 Cr.)	Math 191-192-193 (9 Cr.)	Math 202 (4 Cr.)	Math 280 (5 Cr.)	Math for Elementary Teachers (9 Cr.)
George Mason University (S)	Math 101 (No Cr.)	Math 103-104 (9 Cr.)		Math 252 (3 Cr.)	GHS 371-272 (9 Cr.)
Longwood College (S)					Math 123-124 (9 Cr.)
Madison College (S)	Math 125-126 (9 Cr.)	Math 105-106 (9 Cr.)	Math 360 (4 1/2 Cr.)	Math 220 (4 1/2 Cr.)	Math 107-108 (9 Cr.)
Mary Washington College (S)	Math 111 (4 1/2 Cr.)	Math 101 (4 1/2 Cr.)			
Norfolk State College (S)	Math 51 (3 Cr.)		Math 155 (3 Cr.)	Math 151-152 (6 Cr.)	Math 47-48 (6 Cr.)
Old Dominion University (S)	Math 112-113 (9 Cr.)			Math 130 (4 1/2 Cr.)	Math 109-110 (9 Cr.)
Radford College (Q)	Math 101-104-105 (9 Cr.)	Math 101-103-207 (9 Cr.)	Math 207 (3 Cr.)	Stat 201 (3 Cr.)	Math 211-212-218 (9 Cr.)
University of Virginia (Applied) (S)					
University of Virginia (S)		Math 105 (4 1/2 Cr.)		Math 112 (4 1/2 Cr.)	
Virginia Commonwealth University (S)	Math 101-102 (9 Cr.)	Math 113-114 (9 Cr.)	Math 310 (4 1/2 Cr.)	Math 213 (4 1/2 Cr.)	Math 115-116 (9 Cr.)
V. M. I. (S)	Math 100	Math 118 (4 1/2 Cr.)	Math 205 (4 1/2 Cr.)	Math 326 (4 1/2 Cr.)	
V. P. I. & S. U. (Q)	Math 1011-1012 or Math 1521 (3 Cr.)	Math 1020 (3 Cr.)	Math 3521 (3 Cr.)	Stat 2011 (3 Cr.)	Math 1611-1612-1613 (12 Cr.)
Virginia State College (S)	Math 14-15 (12 Cr.)			Stat 110 (4 1/2 Cr.)	Math 23-24 (9 Cr.)
William and Mary (S)	Math 103 (4 1/2 Cr.)	Math 105-106 (9 Cr.)	Math 211 (4 1/2 Cr.)		

S indicates a school on the semester system.
Q indicates a school on the quarter system.

MATH 206, SURVEY OF MATHEMATICAL CONCEPTS, (1 cr.). This course is applicable to students enrolled in the secretarial sciences. Its purpose is to familiarize the student with the meanings and importance of mathematical symbols, equations, and formulas used in scientific research. Lecture 1 hour per week.

MATH 211, ADVANCED TECHNICAL MATHEMATICS, (3 cr.). Prerequisite is Math 113. Calculus, the derivative and its applications, derivatives of trigonometric functions, integration of basic forms, the definite integral, application of the integral, integration techniques. Lecture 3 hours per week.

MATH 274, APPLIED MATHEMATICS, (4 cr.). Prerequisite is Math 243 or equivalent. The course includes power series, Laplace Transform, partial differential equations. Legendre Polynomials, and Fourier Series. Lecture 4 hours per week.

Perhaps these sequences play an important role in some special programs, but, if so, they are getting only limited exposure at the community colleges.

COMMENTS FROM MATH CHAIRPERSONS

The questionnaire received by each chairperson at a four-year institution contained an item inviting general comments concerning curriculum articulation. Many of the responses to that item were most informative, and summaries of each are included below.

Norfolk State College

With the exception of Math 191-192-193, Norfolk State College reported courses similar to all of the community college courses listed in Tables 2 and 3. They also noted that they submitted a report to the Virginia Community College System in regard to transfer credits. Consequently, any community college sending a large number of transfer students to Norfolk State should probably request a copy of this report.

Old Dominion University

The community college Math sequences 141-142-143 and 241-242-243 (totaling 27 credits) may be transferred as either Math 115-207-208-308 (27 credits) or Math 115-211-212-213-308 (30 credits) at Old Dominion U.

Madison College

Madison College's Math 385 has been renumbered Math 237. Math 386, Differential Equation 1 (3 semester hours) does not appear in the current catalog, but this course will be listed in the new catalogs. Math 205-206

(6 semester hours) is designed for students who need some exposure to calculus, but this sequence is not open to mathematics, physics, or chemistry majors.

Mary Washington College

Courses for which 4 1/2 credits are given (see Tables 2 and 3) are one-semester courses at Mary Washington. The community colleges' Math 202 and Math 280 may be accepted depending upon which textbook is used and the rigor of the course.

The College of William and Mary

The community colleges' Math 241-242-243 seems to be equivalent to Math 212, but Math 241-242 without Math 243 is not. The community colleges' Math 261-262-263 probably omits some topics which are included in Math 212.

University of Virginia

In the Department of Applied Math and Computer Science, a department in the School of Engineering and Applied Science, there will be no transfer problems for students who have satisfactorily completed the entire sequences of Math 141-142-143 and 241-242; however, problems occur if only part of the sequence is completed because no good one-to-one match exists. If the community colleges' Math 243 does not go beyond the topics covered in the calculus book, then this course would not be acceptable for APMA 206.

Virginia Polytechnic Institute and State University

Community college Math 242 should include topics from linear algebra

in order to be equivalent to Math 2212. No community college course is presently equivalent to VPI & SU's Math 1611-1612-1613 (formerly Math 110-120-130). VPI & SU's Math 1521, which includes topics of matrix algebra, inverses of matrices, row-reduced matrices and systems of equations, is a new course tailored for business majors. At present, no community college except Northern Virginia (Math 131-132) is presently providing an equivalent course.

CONCLUDING REMARKS

In conclusion, then, it would appear that the mathematics courses listed in the Community College Curriculum Guidelines are rather well designed to meet the needs of Virginia's two-year college transfer student. One possible exception is the absence of a course specifically designed to provide a mathematics background for the elementary school teacher. A course of this nature, probably totaling nine quarter hours credit would have widespread transfer characteristics (see Table 3). The present trend in Virginia's senior colleges is for this sequence to be taught in the mathematics department for students at the freshman or sophomore level. Furthermore, many of the mathematics faculty members in the community colleges are teachers with academic backgrounds and interests in the field of education, so they should probably be well prepared to initiate and teach this particular course.

If a mathematics course for elementary teachers were included in the Guidelines, then the way would be cleared for critical analysis of the content of Math 181-182-183, the general education course for students with majors other than mathematics, science, or engineering. After conducting a comprehensive study of a course of this nature, CUPM published a report entitled A Course in Basic Mathematics for Colleges in January, 1971. It is difficult to overemphasize the importance of this study to the undergraduate mathematics curriculum in general and to that of the community college in particular. It may well be the case

that the two-year colleges will lead the development of the general education curriculum over the next decade. At any rate, a comprehensive evaluation of 181-182-183 seems appropriate.

Finally, it would certainly be desirable to have someone associated with the community college system update the type of information that we have included in our tables and appendices every year. We have been impressed with the dynamic nature of the four-year institution's mathematics curricula. If the number of course and text changes that we observed during the period of our study is indicative of the normal transitional nature of the senior college's curricula, then we would be amazed to learn that anyone could keep abreast of these changes even if he made an effort to do so. To try to coordinate this type of information without benefit of tables and appendices similar to those included in this report must border on the impossible.

Appended to this report are two tables, listing those textbooks currently used at the four-year and community colleges respectively examined in this study. It is our experience that these tables may constitute the most valuable section of the report, since it is apparently the case that many college courses are textbook-oriented, and to know the text is to know the nature of the course.

Appendices 1 and 2 contain the authors' names, textbook titles, and publishers of those books listed in Tables 4 and 5.

Table 4

Textbooks Used at Four-Year Colleges

	Math 141-142-143	Math 161-162	Math 163	Math 181-182-183	Math 241-242	Math 243	Math 261-262-263 Math 271-272-273
George Mason University	Thomas	Weistein			Thomas	Simmons	
Longwood College	Purcell	Rees & Sparks	Wooton & Drooyan	Miller & Heeren	Purcell	Rainville & Bedient	Purcell
Madison College	Purcell	Vance	Coughlin	Byrne	Purcell	Bronson	Coughlin
Mary Washington College	Sallas & Hille	Munem & Yizze		Turner & Prouse	Sallas & Hille	Ross	Sallas & Hille
Norfolk State College	Leithold	Beckenbach & Drooyan	Crowdis	Jordan	Leithold	Rainville & Bedient	Leithold
Old Dominion University	Swokowski	Swokowski	Swokowski	Campbell & Spencer	Thomas	Spiegel	Strange & Rice
Radford College	Riddle	Munem & Yizze	Riddle		Riddle	Ross	Riddle
University of Virginia (Applied)	Duren				Duren	Boyce & DiPrima	
University of Virginia	Sallas & Hille				Sallas & Hille		
Virginia Commonwealth University	Leithold	Farley, Schedler & Wood		Johnson & McNerney	Leithold		Leithold
V. M. I.	Riddle				Riddle	Rainville & Bedient	
V. P. I. & S. U.	Thomas	Beckenbach & Drooyan	Burdette	Campbell & Spencer	Thomas	Robenstein	Burdette
Virginia State College	Clark	Howes	Bonic	Meserve & Sobel		Boyce & DiPrima	
William and Mary				Stein, Lipshutz, Kennedy & Soloman	William, Crowell & Trotter		Sallas & Hille

Table 5

Textbooks Used at Community Colleges

	Math 141-2-3 Math 241-2	Math 151-152-153	Math 161-162-163*	Math 261-262-263	Math 271-272-273	Math 181-182-183	Math 191-192-193	Math 243
Blue Ridge	Protter & Morrey	Roueche	Munem & Yizze			Keedy		Protter & Morrey
Central Virginia	Purcell		Beckenbach & Drooyan (56)		Goodman	Jacobs		Ayers
D. S. Lancaster			Fisher & Zieber	Fisher & Zieber		Wilderding & Hayward		Thomas
Danville	Protter & Morrey	Roueche	William (9)	Crowdis, Shelly & Wheeler		Newmark & Lake		Kreyszig
Eastern Shore	Thomas	Gossage	Dorsett			Hart		Thomas
Germanna	Thomas	Roueche	Shockley			Graham		
J. Sargeant Reynolds	Thomas	Piper, Gruber & Fairbanks	Munem & Yizze (59)		Thomas	Richardson		
John Tyler	Johnson & Kiokemeister	Roueche	Hardy		Stein	Wheeler	Goodman & Ratti	
Lord Fairfax		Roueche	Vance			Fuller		Sallas & Hille
Mt. Empire			Vance (55)		Stein	Hackert		
New River	Leithold	Roueche	Munem & Yizze (55)		Gillman & McDowell	Lial & Miller		Thomas
Northern Virginia	Purcell		Beckenbach & Drooyan	Saltz		Turner & Prouse	Misraha & Sullivan	Rainville & Bedient
Patrick Henry	Brixey & Andree	Roueche	Beckenbach & Drooyan (43)	Burdette		Turner & Prouse	Misraha & Sullivan	Oakley
Paul D. Camp	Purcell	Roueche	Allendoerfer & Oakley			Bush & Young		Boyce & DiPrima
Piedmont Virginia	Purcell		Munem & Yizze		Goodman	Meserve & Sobel		Purcell
Rappahannock		Roueche	Beckenbach & Drooyan (4)			Turner & Prouse		
Southside Virginia		Curtis	Allendoerfer & Oakley		Thomas	Turner & Prouse		
Southwest Virginia	Riddle		Lial & Miller (58)			Triola		Simmons
Thomas Nelson	Purcell	Roueche	Cameron			Nichols		Purcell
Tidewater		Kaliski	Backenbach & Drooyan (57)			Newmark & Lake		Purcell
Virginia Highlands	Stein	Kaliski	Forbes			Smith		
Virginia Western	Thomas	Roueche	Munem & Yizze (44)		Rees & Sparks	Triola		Kells
Wytheville	Purcell	Roueche	Beckenbach & Drooyan (39)			Rees		Rabenstein

*( ) Denotes that the numbered texts in Appendix I (Textbooks Used at Community Colleges) are used in Math 163.

APPENDIX I

TEXTBOOKS USED AT COMMUNITY COLLEGES

1. Allendoerfer and Oakley, Fundamentals of Freshman Mathematics, McGraw-Hill.
2. Ayres, Theory and Problems of Mathematics of Finance, Schaum Publishing Company.
3. Beckenbach and Drooyan, Modern College Algebra and Trigonometry, 2nd. ed., Wadsworth.
4. Bonic, Cranford, and Krantz, Calculus, Heath.
5. Brixey and Andree, Fundamentals of College Mathematics, Holt, Rinehart, and Winston.
6. Burdette, An Introduction Analytic Geometry and Calculus, Academic Press.
7. Bush and Young, Foundations of Mathematics, McGraw-Hill.
8. Clark, Calculus and Analytic Geometry, Heath.
9. Crowdis, Shelly, and Wheeler, Calculus for Business, Biology, and the Social Sciences, Glencoe Press.
10. Curtis, Practical Mathematics for Business, Houghton-Mifflin.
11. Dorset, Integrated Algebra and Trigonometry, Allyn and Bacon.
12. Fisher and Zieber, Integrated Algebra and Trigonometry with Analytical Geometry, 7th ed., Prentice-Hall.
13. Fuller, Algebra and Trigonometry, McGraw-Hill.
14. Gillman and McDowell, Calculus, Norton.
15. Goodman, Modern Calculus with Analytic Geometry, Macmillan.
16. Goodman and Ratti, Finite Mathematics with Applications, Macmillan.
17. Gossage, Business Mathematics: A College Course, Southwestern.

18. Hackert, Finite Mathematics, Heath.

19. Hardy, Pre-Calculus Mathematics, Charles E. Merrill Publishing Company.

20. Hart, Mathematics for Managerial and Social Science, Prindle, Weber, and Schmidt.

21. Jacobs, Mathematics: A Human Endeavor, W. H. Freeman and Company.

22. Johnson and Kiokemeister, Calculus with Analytic Geometry, 4th ed., Allyn and Bacon.

23. Kaliski, Business Mathematics, Harcourt, Brace, Jovanovich.

24. Keedy, Modern Introduction to Basic Mathematics, Addison-Wesley.

25. Kells, Elementary Differential Equations, 6th Ed., McGraw-Hill.

26. Kreyszig, Advanced Engineering Mathematics, 3rd ed., John Wiley and Sons.

27. Leithold, The Calculus, Harper and Rowe.

28. Lial and Miller, Mathematics, Scott, Foresman.

29. Meserve and Sobel, Contemporary Mathematics, Prentice-Hall.

30. Misrahi and Sullivan, Finite Mathematics with Applications, John Wiley and Sons.

31. Munem and Yizze, Functional Approach to Pre-Calculus, Worth Publishers.

32. Newmark and Lake, Mathematics as a Second Language, Addison-Wesley.

33. Piper, Fairbank and Gruber, Applied Business Mathematics, 9th ed., Southwestern.

34. Protter and Morrey, College Calculus with Analytic Geometry, Addison-Wesley.

35. Prouse and Turner, Principles of Mathematics, Scott, Foresman.

36. Purcell, Calculus with Analytic Geometry, 2nd ed., Appleton, Century, Crofts.

37. Rainville and Bedient, A Short Course in Differential Equations, Macmillan.

38. Rees, Principles of Mathematics, Prentice-Hall.

39. Rees and Sparks, Calculus with Analytic Geometry, McGraw-Hill.

40. Riddle, Calculus and Analytic Geometry, McGraw-Hill.

41. Richardson, Fundamentals of Mathematics, 4th ed., Macmillan.

42. Roueche, Business Mathematics, Prentice-Hall.

43. Saltz, A Short Calculus, Goodyear Publishing Company.

44. Shockley, Brief Calculus, Holt, Rinehart, and Winston.

45. Simmons, Differential Equations with Applications and Historical Roles, McGraw-Hill.

46. Smith, The Nature of Modern Mathematics, Brooks-Cole.

47. Stein, Calculus and Analytic Geometry, McGraw-Hill.

48. Stein, Calculus in the First Three Dimensions, McGraw-Hill.

49. Thomas, Calculus and Analytic Geometry, 3rd ed., Addison-Wesley.

50. Turner and Prouse, Principles of Mathematics, Scott, Foresman.

51. Triola, Mathematics and the Modern World, Cummings Publishing Co.

52. Vance, An Introduction to Modern Mathematics, Addison-Wesley.

53. Wilderding and Hayward, Mathematics: The Alphabet of Science, John Wiley and Sons.

54. Williams, (Untitled Notes), Danville Community College.

55. Schock and Warsaw, Analytical Geometry and An Introduction to Calculus, Prentice-Hall.

56. Schachter, Calculus and Analytic Geometry, McGraw-Hill.

57. Ceder and Outcalt. A Short Course In Calculus, 2nd Ed., Worth.

58. Thacker, Calculus Notes for Math 163, (Unpublished Notes), Southwest Virginia Community College.

59. Smith, Moore, and Green, Calculus Handouts for Math 163, (Unpublished Notes), J. Sargeant Reynolds Community College.

APPENDIX II

TEXTBOOKS USED AT FOUR-YEAR COLLEGES

1. Beckenbach and Drooyan, Modern College Algebra and Trigonometry, 2nd ed., Wadsworth.
2. Bonic, Calculus, D.C. Health & Co.
3. Boyce and DiPrima, Differential Equations, John Wiley and Sons.
4. Bronson, Schaum's Outline Series - Theory and Problems of Modern Introductory Differential Equations, McGraw-Hill.
5. Burdette, An Introduction to Analytic Geometry and Calculus, Academic Press.
6. Byren, Modern Elementary Mathematics, McGraw-Hill.
7. Campbell and Spencer, Finite Mathematics, Macmilliam.
8. Clarke, P.S., Calculus and Analytic Geometry, D.C. Health & Co.
9. Coughlin, Elementary Applied Calculus - A Short Course, Allyn & Bacon Inc.
10. Crowdis, Shelly, and Wheeler, Calculus for Business, Biology, and the Social Sciences, Glencoe Press.
11. Duren, Calculus and Analytic Geometry, Xerox Publishers.
12. Farley, Schedler, and Wood, Trigonometry - Unified Approach, Prentice-Hall.
13. Howes, Pre-Calculus Mathematics, John Wiley and Sons.
14. Jordan, Focus on A New Look at Mathematics, Kendall Hunt Publishing Co.
15. Kennedy and Solomon, Ten Statement Fortran Plus Fortran IV, Prentice-Hall.
16. Leithold, The Calculus with Analytic Geometry, Harper and Row.
17. Lipshutz, Probability, McGraw-Hill.
18. Meserve and Sobel, Contemporary Mathematics, Prentice-Hall.

19. Miller and Herren, Mathematical Ideas, Scott, Foresman Co.

20. Munem and Yizze, Functional Approaches to Pre-Calculus, Worth Publishers.

21. Newmyer and Klentos, Intermediate Algebra, Charles E. Merrill Publishing Company.

22. Owen, Finite Mathematics, Saunders.

23. Purcell, Calculus with Analytic Geometry, 2nd. ed., Appleton, Century, Crofts.

24. Rainville and Bedient, A Short Course in Differential Equations, Macmillan.

25. Rees and Sparks, Algebra and Trigonometry, McGraw-Hill.

26. Riddle, Calculus and Analytic Geometry, Wadsworth.

27. Robenstein, Elementary Differential Equations with Linear Algebra, Academic Press.

28. Ross, Introduction to Ordinary Differential Equations, 2nd ed., Xerox Publishers.

29. Salas and Hille, Calculus, Xerox Publishers.

30. Simmons, Differential Equations, McGraw-Hill.

31. Speigel, Applied Differential Equations, Prentice-Hall.

32. Stein, Mathematics: The Man-Made Universe, W. H. Freeman and Company.

33. Strange and Rice, Analytic Geometry and Calculus, With Technical Applications, Addison-Wesley.

34. Swokowski, College Algebra and Trigonometry, Prindle, Weber, and Schmidt.

35. Thomas, Calculus and Analytic Geometry, 4th ed., Addison-Wesley.

36. Triola, Mathematics and the Modern World, Cummings Publishing Co.

37. Turner and Prouse, Principles of Mathematics, Scott, Foresman.

38. Vance, Unified Algebra and Trigonometry, Addison-Wesley.

39. Weistein, Precalculus Mathematics: A Fundamental Approach, Benjamin.

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